Traumatic Brain Injury–Related Deaths From Firearm Suicide: United States, 2008–2017

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Objectives. To document the increasing influence of firearm suicide on the incidence of traumatic brain injury (TBI)–related death in the United States.

Methods. We used national vital statistics data from 2008 to 2017 to identify TBI-related deaths, overall and by cause, among US residents. National counts stratified by year, sex, and age group (to facilitate age adjustment) were merged with corresponding population estimates to calculate incidence rates.

Results. During the 10-year period beginning in 2008, when it became the leading cause of TBI-related death in the United States, firearm suicide accounted for nearly half (48.3%) of the increase in the absolute incidence of TBI-related death when combining all injury categories showing absolute increases. Rates of TBI-related firearm suicide increased among both males and females.

Conclusions. Safe storage of firearms among people at risk and training of health care providers and community members to identify and support people who may be thinking of suicide are part of a comprehensive public health approach to suicide prevention.

Public Health Implications. States, communities, and health care systems can save lives by prioritizing comprehensive suicide prevention. (*Am J Public Health.* 2020;110:897–899. doi:10.2105/AJPH.2020.305622)

Traumatic brain injury (TBI) is a major cause of death and disability in the United States. TBI may be due to blunt (closed) or penetrating injury.[1] Clinical presentation, prognosis, and pathophysiology differ, leading many researchers to exclude penetrating injuries from analyses. However, penetrating injury is frequently indicated for TBI-related death and requires greater attention. Young children, older adolescents, young adults, and adults aged 65 years and older have had the highest rates of TBI variously resulting in an emergency department visit, hospitalization, or death, with rates for males higher than rates for females across all ages.[2] In 2017, approximately one fourth of all injury-related deaths (61 134 of 243 039) among US residents involved a diagnosis indicating TBI.[3] These deaths resulted in estimated work loss and medical costs exceeding $50 billion in 2017 dollars.[4]

Motor vehicle traffic, unintentional falls, and firearms have long been recognized as the 3 major injury mechanisms associated with TBI-related death in the United States; however, their relative influence has changed over time.[3,5] In 2008, firearm suicide became the leading cause of TBI-related death in the United States, representing 28.8% of all such deaths.[3] By 2017, firearm suicide accounted for one third of all TBI-related deaths nationally, with unintentional falls and motor vehicle traffic injuries representing the second and third leading causes.[3] Varying case fatality rates for the specific types of head injuries typically seen with these different injury mechanisms might influence this ranking. Previous data indicate that approximately 90% of firearm-related TBIs are fatal, compared with approximately 20% of transport-related TBIs and 10% of fall-related TBIs.[5] More recent data indicate that approximately 99% of TBI-related deaths with a firearm as the mechanism of injury involved a diagnosis of open wound or crushing wound to the head, whereas approximately 1% of TBI-related deaths from falls or motor vehicle crashes involved such diagnoses.[3]

Approximately half of all suicides involve the use of a firearm.[6] Limiting access to lethal means, such as firearms, among people at risk is part of a comprehensive approach to suicide prevention that can reduce TBI-related deaths.[7] Such an approach has relevance for communities and health care providers and systems and seeks to reduce suicide risk in the first place and support people who may be struggling with thoughts of suicide or suicide attempts.

To our knowledge, the intersection of TBI-related death and firearm suicide has not been closely evaluated. We used national mortality data to document the increasing influence of firearm suicide on the incidence of TBI-related death in the United States.

METHODS

We used comprehensive mortality data from the National Vital Statistics System covering the years 2008 to 2017 to tabulate counts of TBI-related deaths, overall and by cause, among US residents. We initially identified injury-related deaths by screening

records for *International Classification of Diseases, 10th Revision* (*ICD-10;* Geneva, Switzerland: World Health Organization; 1992), underlying-cause-of-death codes V01 to Y36, Y85 to Y87, Y89, and U01 to U03. Each injury-related death was then classified as TBI related if any *ICD-10* multiple-cause-of-death codes in the death record indicated a TBI diagnosis.[2] TBI–related deaths were further classified by injury intent and mechanism based on the National Center for Health Statistics ICD-10: External Cause of Injury Mortality Matrix.[8] Because suicide intent is difficult to ascribe to young children, a small number (n = 27) of provisional suicide cases for decedents younger than 10 years were not classified as suicide but were included in the study data as TBI-related deaths based on the other screening criteria. Cases of TBI-related firearm suicide were further classified by place of death (home; medical facility—inpatient, outpatient or emergency department, dead on arrival; and other or unknown). A total of 547 853 records indicating TBI-related death were included in the study data set.

National case counts were tabulated by year, sex, and 5-year age group (to facilitate age adjustment) and merged with corresponding US population estimates to allow calculation of annual incidence rates. Rates are expressed per 100 000 persons (≥ 10 years old for suicide) and were age adjusted to the US year 2000 standard.

RESULTS

During the 10-year period beginning in 2008, firearm suicide contributed substantially to the overall increase in the incidence of TBI-related death. Considering only those injury categories with 10-year increases in numbers of TBI-related deaths, firearm suicides accounted for the largest proportion of the combined increase (48.3%), followed by unintentional falls (44.8%), firearm homicides (4.3%), nonfirearm suicides (1.2%), injuries of undetermined intent (0.9%), and legal intervention (0.4%; data not shown). Age-adjusted annual rates of TBI-related death from all causes and TBI-related firearm suicides over the 10-year study period (Table 1) parallel these findings. Although rates for all-cause TBI-related death and TBI-related firearm suicide both increased over the study period, the absolute increase in the age-adjusted TBI-related firearm suicide rate (+1.38 per 100 000) exceeded the absolute increase in the rate of TBI-related death from all causes (+0.63 per 100 000). In relative terms, the TBI-related firearm suicide rate increased 24.5%, whereas the rate for all TBI-related deaths increased by 3.7%.

Age-adjusted rates of all TBI-related death and TBI-related firearm suicide increased for both males and females over the study period (Table 1), with rates for males notably higher than those for females. The absolute increase in the TBI-related firearm suicide rate for males (+2.13 per 100 000) exceeded the absolute increase for females (+0.55 per

100 000), whereas the relative increase for males (+20.3%) was less than that for females (+43.3%).

The place of death for most TBI-related firearm suicides was the decedent's home (60.3%–62.4% each year). Place of death was less frequently listed as medical facility—inpatient (5.5%–6.5%), outpatient or emergency department (6.1%–7.0%), and dead on arrival (0.8%–1.6%)—with a gradual decrease in this last category over the study period.

DISCUSSION

The study findings indicate that the relative influence of firearm suicide on the incidence of TBI-related death has increased. From 2008 to 2017, approximately 50% to 51% of all suicides each year involved a firearm.[4] By contrast, approximately 97% of all TBI-related suicides each year involved a firearm.[3]

The age-adjusted rate of TBI-related firearm suicide compared with the age-adjusted rate of TBI-related death overall showed steady, and larger, increases between 2008 and 2017. During this period, the TBI-related firearm suicide rate increased 24.5%, whereas the rate for TBI-related deaths overall increased 3.7%. The age-adjusted overall firearm suicide rate increased by 19.1%, and the age-adjusted overall suicide rate

TABLE 1—Counts and Rates of Traumatic Brain Injury (TBI)–Related Death and TBI-Related Firearm Suicide: United States, 2008–2017

Year	Both Sexes, No. (Rate)		Males, No. (Rate)		Females, No. (Rate)	
	All TBI-Related Death	TBI-Related Firearm Suicide[a]	All TBI-Related Death	TBI-Related Firearm Suicide[a]	All TBI-Related Death	TBI-Related Firearm Suicide[a]
2008	52 444 (16.84)	15 118 (5.63)	38 917 (26.77)	13 380 (10.49)	13 527 (7.97)	1 738 (1.27)
2009	51 178 (16.21)	15 506 (5.71)	37 658 (25.57)	13 674 (10.58)	13 520 (7.85)	1 832 (1.33)
2010	51 271 (16.05)	16 037 (5.85)	37 661 (25.34)	14 232 (10.89)	13 610 (7.75)	1 805 (1.29)
2011	52 296 (16.11)	16 723 (6.01)	38 449 (25.41)	14 638 (11.02)	13 847 (7.78)	2 085 (1.48)
2012	53 604 (16.29)	17 081 (6.07)	39 363 (25.63)	14 958 (11.10)	14 241 (7.90)	2 123 (1.50)
2013	54 185 (16.25)	17 758 (6.25)	39 675 (25.52)	15 481 (11.38)	14 510 (7.91)	2 277 (1.59)
2014	54 948 (16.24)	17 985 (6.25)	40 202 (25.49)	15 664 (11.35)	14 746 (7.94)	2 321 (1.61)
2015	57 253 (16.77)	18 661 (6.45)	41 894 (26.26)	16 205 (11.63)	15 359 (8.19)	2 456 (1.70)
2016	59 540 (17.25)	19 574 (6.71)	43 531 (26.92)	16 951 (12.04)	16 009 (8.46)	2 623 (1.81)
2017	61 134 (17.47)	20 619 (7.01)	44 964 (27.45)	17 966 (12.62)	16 170 (8.43)	2 653 (1.82)

Note. Rates are per 100 000 residents per year and are age adjusted to the US year 2000 standard population.
[a]Suicide statistics represent decedents and populations aged 10 years or older.

increased by 20.7%, with rates for both steadily increasing throughout the study period.[4]

Although previous research has highlighted the influence that increased prevention and education initiatives had on the decline in TBI-related motor vehicle traffic deaths,[9] prevention of firearm suicide and suicide in general has proven more complex, especially in the context of acute suicidal crises. Previous research suggests that means restriction, such as detoxification of domestic gas[10] and restricted pack sizes of over-the-counter paracetamol and salicylates,[11] reduced suicide rates and numbers, respectively. Similarly, safe storage of firearms can put time and distance between a suicidal individual and lethal means. With added time, the crisis may pass, or less lethal means may be sought.[12]

On the basis of prevailing rates, prevention efforts directed toward firearm suicide are indicated across the life span, including older adulthood.[4,7] Although firearm suicide counts begin to decline after the sixth decade of life, older adults, particularly men, have the highest rates of firearm suicide, and firearms are used in nearly two thirds of suicides among this group.[4] Unlike other less lethal methods (e.g., poisoning, cutting), attempted suicide with a firearm leaves little chance for lifesaving intervention.[12] Safe firearm storage among people at risk along with training health care providers and community members to identify and support people who may be thinking of suicide are important parts of a comprehensive public health approach to suicide prevention. Such an approach also includes preventing suicide risk in the first place (e.g., by teaching problem-solving skills, promoting connectedness, and strengthening economic supports) and caring for people bereaved by suicide.[7] **AJPH**

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